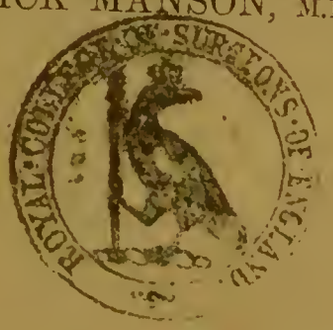
REPORT

ON

HÆMATOZOA.

BY

PATRICK MANSON, M.D.



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ALLUSION has been made by Drs. SOMERVILLE and JAMIESON, in recent numbers of these Reports, to a condition known as "worms in the heart," to which the dog in China is peculiarly liable. Any one who has had much acquaintance with dogs in these parts must be aware of their liability to sudden and apparently unaccountable death; and the medical practitioner is often asked to perform a post-mortem examination with the view of clearing up or confirming the suspicion of poisoning which is so commonly entertained in such cases. Ten chances to one the cause of death is found to be plugging of the pulmonary artery, or mechanical interference with the action of the valves of the heart, by a mass of filariæ occupying the artery and cavities of the right side. I have had many opportunities of seeing this affection. I am aware that a similar disease is known in America, France and Italy, and probably elsewhere, and that the "worm" has been more or less carefully described by various authors; but as I presume that, like myself, most medical practitioners in China do not possess works on the subject, and have no opportunity of consulting them, my observations may be of some value notwithstanding their crudeness.

Prevalence of Entozoa amongst Dogs in China.—Besides the usual and well known external pests, there is quite a large number of different parasites infesting both foreign and Chinese dogs. I am familiar with at least five species occupying the alimentary canal, viz., two kinds of tænia, a thread-worm inhabiting the small intestine, and two round worms like the human lumbricus. In addition to these is the heart-worm, variously named *Filaria canis cordis* or *Filaria immitis*, and a new species, not hitherto described as existing in the dog in China, the *Filaria sanguinolenta*. The latter I have alluded to in a former report, (*C. M. R.* No. 10, p. 9) as having been discovered by Dr. LEWIS in the pariah dog of Calcutta, and most of his observations I have been able to confirm. I propose to describe both *Filaria immitis* and *Filaria sanguinolenta*, as an acquaintance with the appearance and habits of both is necessary to understand the lesions they produce, and to prevent mistakes and false conclusions on an important point in the history of *Filaria immitis*, viz., the process by which it obtains access to the circulation of its host.

FILARIA IMMITIS.

Its Prevalence.—The extent of this is difficult to estimate without much and laborious investigation, but if I say that one-half of all dogs in China (my remarks apply especially to Amoy), whether native or foreign, are the hosts of this parasite, I believe I am within the truth; two out of three is nearer it, and is not, I think, an over-statement. Any one can satisfy himself on this point by examining with the microscope the blood of the first half-dozen dogs he can procure, and to do so it is not necessary to kill the animal.

Mode of examining the Blood for Embryos.—The plan I adopt is to make a small incision with a sharp knife on the inner surface of the ear, where the skin is not covered by hair, and from this to express sufficient blood to supply six or eight slides. These I carefully search with a low power, and the probability is, that in one or all of them one or more immature filariæ will be discovered. From observations thus made, and in some cases confirmed by post-mortem examination, the following Table has been drawn up, and I conclude from it that dogs of all ages, and probably every breed, are liable to be attacked by the parasite I am describing.

No.	Breed.	Sex.	Age.	Where from.	Lived in China.	Condition.	No. of Slides Examined.	Amount of Hæmatozoa.	Liable to any form of Disease.
1	English Terrier ...	F.	9 yrs.	Amoy.....	9 yrs.	Well nourished	—	Abundant	Died suddenly.
2 3 4 5	Pups of above.....	—	6 weeks	„	6 weeks	Good	2 from each	None	—
6	Spaniel	M.	—	England...	—	„	6	Very abundant	Canker in ears.
7	Newfoundland	„	3 yrs.	Hongkong	3 yrs.	„	12	Two	—
8	Eurasian, large.....	„	1¼ „	Amoy.....	1¼ „	„	6	None	—
9	„ small ...	„	1½ „	„	1½ „	„	6	„	—
10	Peking Terrier	„	—	—	—	„	6	„	Canker.
11	Italian Greyhound	„	—	—	—	„	6	„	—
12	Bull-terrier	„	1 yr.	Amoy.....	1 yr.	„	6	One	—
13	Dropper,—Setter, Pointer.	„	5½ „	At Sea ...	5½ „	„	1	„	—
14	Setter	„	6 „	Scotland...	3 „	„	6	None	Canker and tape-worm.
15	Newfoundland	„	—	—	—	„	6	One	—
16	Bull-terrier	„	—	China.....	—	Fair	9	None	Fits on exercising.
17	Spaniel	„	5 yrs.	England...	¾ yr.	Good	5	„	—
18	„	„	5 „	„ ...	„	„	1	Several	Many white corpuscles.
19	„	F.	5 „	„ ...	„	Thin	6	None	—
20	Bull-terrier	„	6 „	Amoy.....	6 yrs.	Good	10	„	Fits on excitement.
21	English Terrier.....	M.	2 „	—	—	Very thin	2	Very abundant	Won't fatten.
22	Setter	„	5 „	—	5 yrs.	Good	3	None	Mangy.
23	Newfoundland and Collie.	„	5 „	Australia..	5 „	„	1	One	Weak hind quarters.
24	English Terrier.....	„	—	—	—	„	1	„	—
25	Bull „	„	10 yrs.	England...	8 yrs.	Thin	Several	Abundant	Lost strength and pluck.
26	Chinese, large	„	—	—	—	Good	—	—	Killed.
27	„ „	„	—	—	—	—	Many	None	„
28	„ „	F.	—	—	—	Fair	„	„	„
29	Retriever	M.	4½ yrs.	China.....	4½ yrs.	Good	One	Three.....	—
30	Chinese, small	„	—	„	—	Thin	Several	Very abundant	Killed.
31	„ large	„	Old	„	—	Good	„	None	„
32	„ small	F.	„	„	—	Thin	Many	„	„
33	„ „	M.	—	„	—	Good	Several	„	„
34	„ large	F.	—	„	—	Thin	„	„	„
35	„ „	„	—	„	—	Fair	„	Several	„
36	„ „	„	—	„	—	Good	„	None	„
37	„ „	„	—	„	—	„	„	Several	„
38	„ „	„	—	„	—	„	„	None	„
39	„ „	„	—	„	—	„	„	„	„
40	„ „	—	—	„	—	„	„	„	„

No selection was made of animals for examination.

ANALYSIS OF TABLE.

(1.) Of 40 animals whose blood was examined, the embryos of Filaria immitis were found in 15.

(2.) In 16 post-mortem examinations, Filaria immitis was found in the heart in 8.

(3.) In 14 post-mortem examinations, Filaria sanguinolenta, or lesions produced by it, were found in 9.

POST-MORTEM EXAMINATIONS.

No.

1. Filariæ immites in right ventricle.
25. Lungs tuberculous, pleuritic effusion; F. immitis numerous; F. sanguinolenta not looked for.
26. Four F. immites in right heart and pulmonary artery.
27. Four unimpregnated female filariæ immites in heart; F. sanguinolenta in œsophagus; aorta sacculated.
28. No filariæ in heart or œsophagus.
30. Forty-one F. immites in heart. F. sanguinolenta in pleura and œsophagus.
31. No filariæ in heart, aorta or œsophagus.
32. No F. immitis. Several tumours in aorta, one containing an immature F. sanguinolenta.

No.

33. No F. immitis. F. sanguinolenta in aorta and œsophagus.
34. No filariæ in heart. One aortic tumour, œsophagus healthy.
35. Six F. immites in heart. Several œsophageal tumours containing F. sanguinolenta. One aortic sacculation.
36. Normal.
37. Three or four F. immites in heart. Aorta and œsophagus normal.
38. One large filaria tumour in aorta; otherwise normal.
39. Four small filaria tumours in aorta, with immature worms; otherwise normal.
40. One male filaria immitis in heart; several small tumours in aorta and mature F. sanguinolenta in large œsophageal tumour.

The embryo Filaria.—A glance at Fig. I. (2), will convey an idea of the immature hæmatozoon thus discovered, and may assist the observer to recognize it when met with. According to my measurements, it is about $\frac{1}{100}$ of an inch in length, by $\frac{1}{3000}$ of an inch in breadth, and as far as I can make out is quite structureless. On close examination with a high power, something like a mouth can be seen at the blunt extremity, which appears to be alternately protruded and retracted. (3, 4.) The body attains its greatest diameter a short

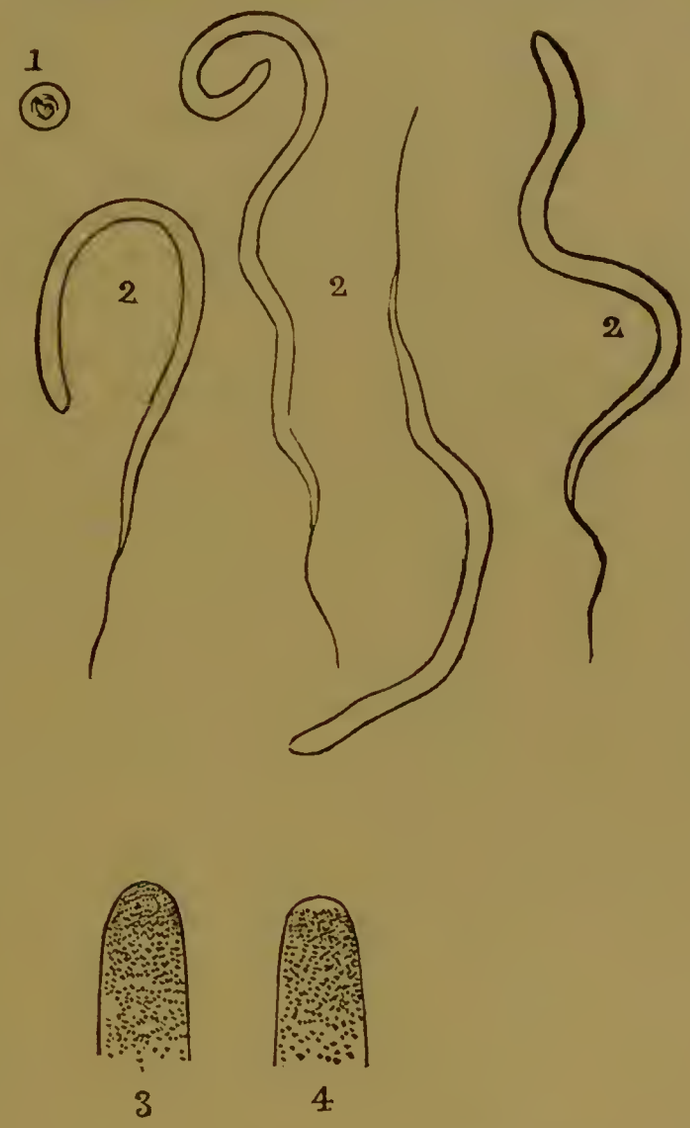

Figure I.—Embryo Filariæ Immites.

1. A blood corpuscle.
2. Free embryos.
3. Head of the latter more highly magnified.
4. The same, showing the appearance (described in the text) of retraction.

distance from this point, and maintains the same thickness for about two-thirds of its length; beyond this point, it gradually tapers off to the long and filiform tail. In freshly drawn blood the animalcule is in constant motion, wriggling about amongst the blood corpuscles with a snake-like movement, and lashing out most vigorously with its supple and slender tail. It never seems to be at rest, and retains its activity as long as the blood continues fluid, often for many hours. It never seems to attach itself to the blood corpuscles or to the surface of the slide. I have

never seen any sign of growth or development in the many specimens I have examined, the measurements and appearance of all being exactly alike.

Their great Number.—So numerous are these creatures in some specimens of blood that I have seen as many as five in full activity in one small field of the microscope. From this some idea may be formed of the vast numbers existing in the total circulation in such a case, and one cannot but wonder that it is possible for a dog, containing such a prodigious number of parasites, to live. I know many dogs thus infested, and who have probably been so for many years, yet they seem in no way inconvenienced by their guests, have attained a good old age, and are fat and well nourished.

The Mature Filaria, its Habitat.—If a dog whose blood is thus infested dies or is killed, the parents of these microscopic filariæ are found coiled up in the right ventricle of the heart for the most part, sometimes extending through the tricuspid valve into the auricle, and even into the superior vena cava, and very generally through the semilunar valves far into the pulmonary artery and its branches. I have never found them, or anything resembling them, in any other vessel, though careful search has been made in all the larger veins. In the heart, their bodies are found after death surrounded for the most part with a dark soft grumous clot, which, on microscopic examination, is found to be swarming with the embryos above described.

Numbers.—Their number varies very much. Sometimes there are only three or four, while in other instances the heart and pulmonary artery are actually stuffed with them, so that one can hardly understand how the circulation can possibly be carried on. The largest number I have counted was forty-one, and in this instance some were probably overlooked, as they extended into the smaller branches of the pulmonary artery, and escaped detection.

Naked eye Appearances.—On opening the heart, the worms are found massed together in a bundle like a coil of thick catgut that has been some time steeping in water. The few sluggish movements they exhibit, after the death of their host, form a striking contrast to the liveliness of their progeny. On unravelling and extending them, they can be separated into two kinds; one sort, the larger and plumper, measure from eight to thirteen inches in length by $\frac{1}{30}$ of an inch in diameter (Fig. II. 1, F.); the other, the smaller, five to seven inches in length by $\frac{1}{40}$ of an inch in diameter. (Fig. II. 1, M.) The former is the female, and is characterized by her superior dimensions and only slightly curved caudal extremity; the latter is the male, and is easily recognized by his fine tail curled up near its extremity, like a corkscrew or the tendril of a creeper. The colour of both is a milky opalescent white, with generally a long, and at places convoluted, thin red streak, most marked near the head, running nearly the whole length of the body—this is the alimentary canal. They feel like whipcord when rolled between the fingers, and can bear considerable strain without breaking. If the body of the female is snapped or cut across, three slender threads can be drawn from one of the severed ends—these are the alimentary canal and the two uterine tubes. On the male being similarly treated, only two threads are observed, the alimentary canal and the testicle.

Proportion of the Sexes.—As a rule, the females are more numerous than the males. In one instance I found four females but no male. The general proportion is about one male to two females. In the instance above mentioned, in which forty-one worms were found together, thirteen were males and twenty-eight females.

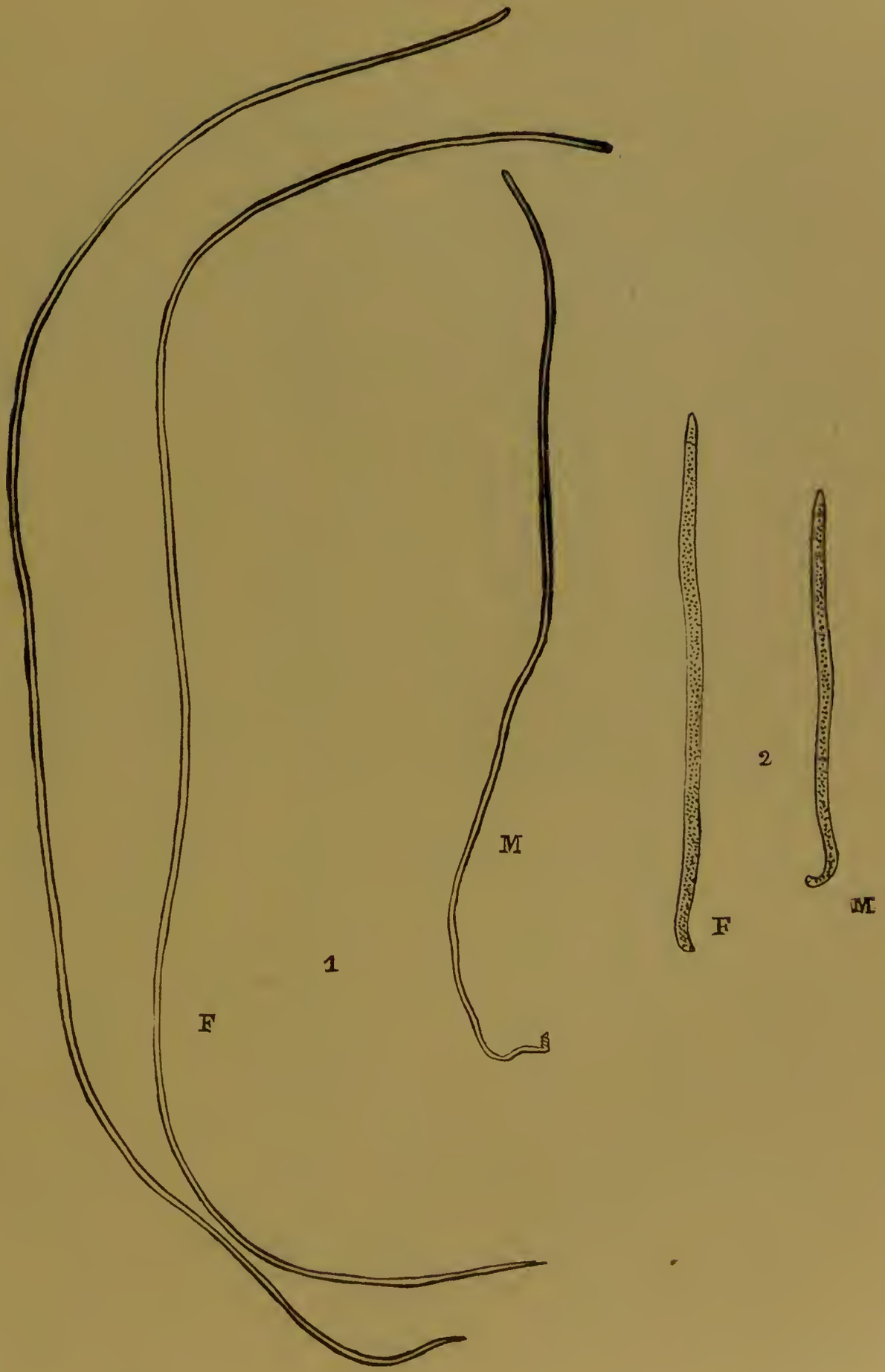

FIGURE II.—FILARIÆ IMMITIS AND SANGUINOLENTA.

1. Filaria immitis, natural size.—*F.*, female; *M.*, male.
2. Filaria sanguinolenta, natural size.—*F.*, female; *M.*, male.

Anatomy of the Mature Worm.—The Coverings appear to be two in number—the tegumentary, a very delicate diagonally striped membrane, continuous at the mouth and anus with the lining of the alimentary canal; and the fibro-muscular, or inner coat, of strong and coarse longitudinal fibres, strengthened about the head by numerous diagonal bands.

The Alimentary Canal commences by a funnel-shaped mouth (Fig. III., 1, 2) placed slightly to one side of the extreme end of the animal. This funnel-shaped opening contracting towards its apex leads to the pharynx and this to the œsophagus, which, running for a short distance directly backwards, terminates in a valvular-like opening in the intestine, about a quarter of an inch from the mouth. This, the main part of the alimentary canal, traverses the whole of the remaining length of the animal, to terminate in an anus placed not quite at the tip of the incurvated tail. For the most part, the course of this tube is straight, but at intervals it winds round the uterine or seminal tubes. It is rather narrower near the anus than elsewhere, but its dimensions seem to depend on the quantity of food, represented by a dark red granular matter, with which it is more or less filled. The œsophagus is usually empty and contracted.

The anatomy of the alimentary canal is about the same in both sexes.

Reproductive Organs of the Female.—The vagina opens at a point close to the union of the œsophagus and intestine. It is a narrow muscular tube, which, after a short and convoluted course, first forwards and then backwards, bifurcates. The two tubes thus formed gradually increase in diameter, and constitute the uterus. These two uterine tubes occupy the greater part of the animal, and extend from within half-an-inch of the head to an inch and a half of the tail. Their course is usually straight and parallel, but at intervals they are twisted round each other. Each terminates quite abruptly (Fig. III., 4) in a very delicate vessel, which after a short and nearly straight course, again gradually expands to about half the diameter of the uterine tubes, and after many turns, doublings and convolutions, ends, close to the tail, in the delicate ovarian tubes. The course of the latter is short and tortuous, and terminates abruptly as represented. (Fig. III., 3.)

Their Contents.—The contents of the female reproductive organs form a very beautiful and striking object for microscopic study, and from them, with a very little care, the whole history of the development of the embryo can be ascertained. To obtain specimens at different stages of development, it is only necessary to divide the body at short intervals with a sharp instrument, and examine the fluid which exudes from the severed ends. If a section is made near the tail, it is sometimes possible to draw or press out the very termination of the ovarian tubes, and after adding a little water, to observe the earliest appearances of the embryo. (Fig. IV., 1 to 7.) This is a globular transparent cell, from $\frac{1}{3000}$ to $\frac{1}{2000}$ of an inch in diameter, with a distinct nucleus and nucleolus. A little farther down the ovary, mixed with the clear globular cells, are others of a granular appearance and elongated form, measuring $\frac{1}{750}$ by $\frac{1}{2000}$ of an inch, with a nucleus and nucleolus dimly visible. Some of them are drawn out into a spine at one end or both, and when massed together, as they often are, resemble a columnar epithelium. Still farther down, the cells enlarge, the circular to $\frac{1}{1000}$, the spindle-shaped to $\frac{1}{500}$ by $\frac{1}{1500}$ of an inch, and are mixed with abundance of bright shining granules, measuring about $\frac{1}{8000}$ of an inch, resembling what is seen in the spermatic fluid of the male worm. About this point the nucleus is seen to be (Fig. IV., 6) divided, and as the examination advances into the uterine

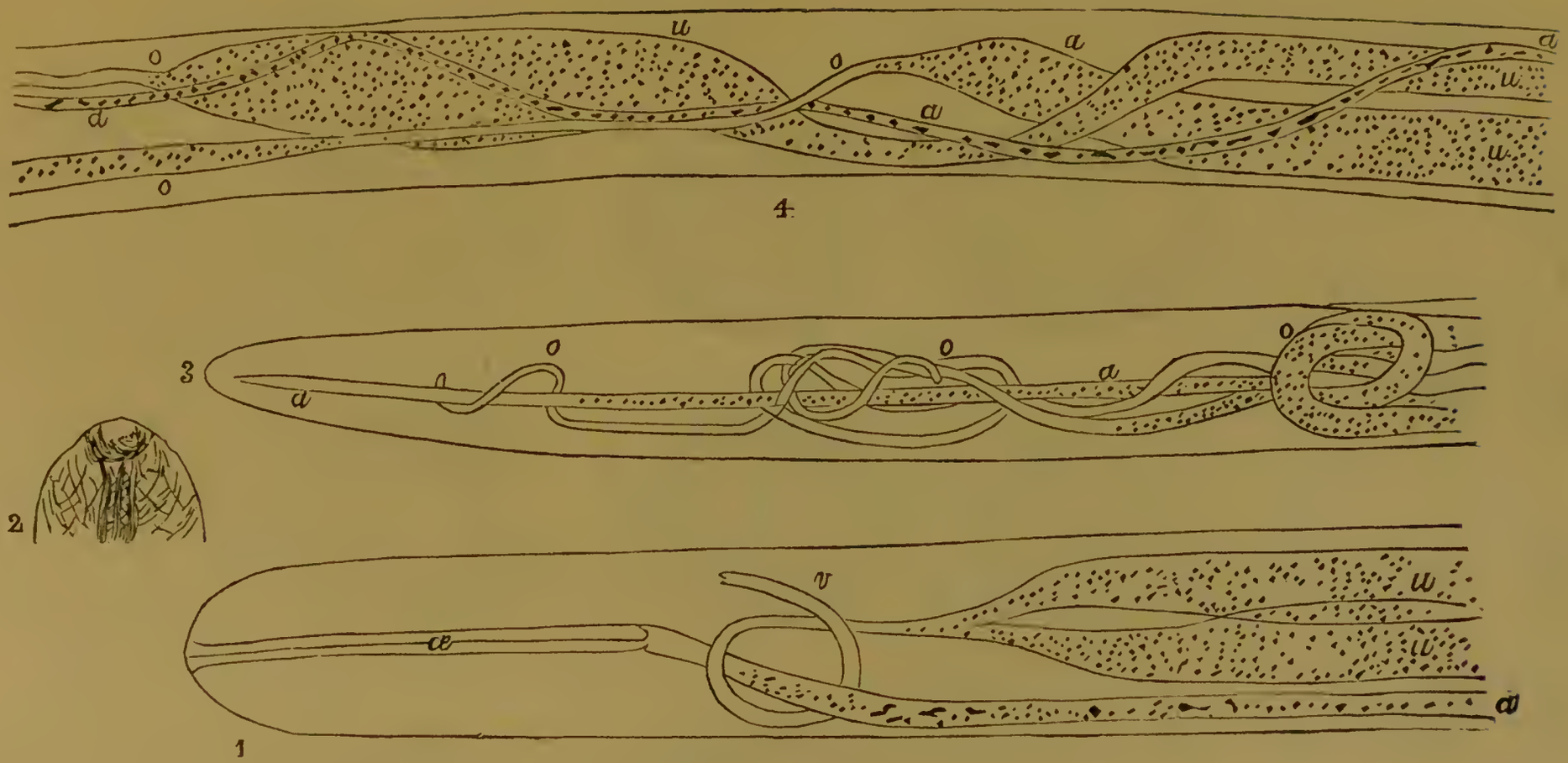

FIGURE III.—FILARIA IMMITIS.

1. *œ*. Œsophagus.
   v. Vagina.
   a. Intestine.
   u. Uterine tubes.
2. The mouth.
3. *o*. Ovarian tubules.
   a. Alimentary canal.
4. *u*. Uterine tubes.
   a. Alimentary canal.
   o. Ovarian tubules.

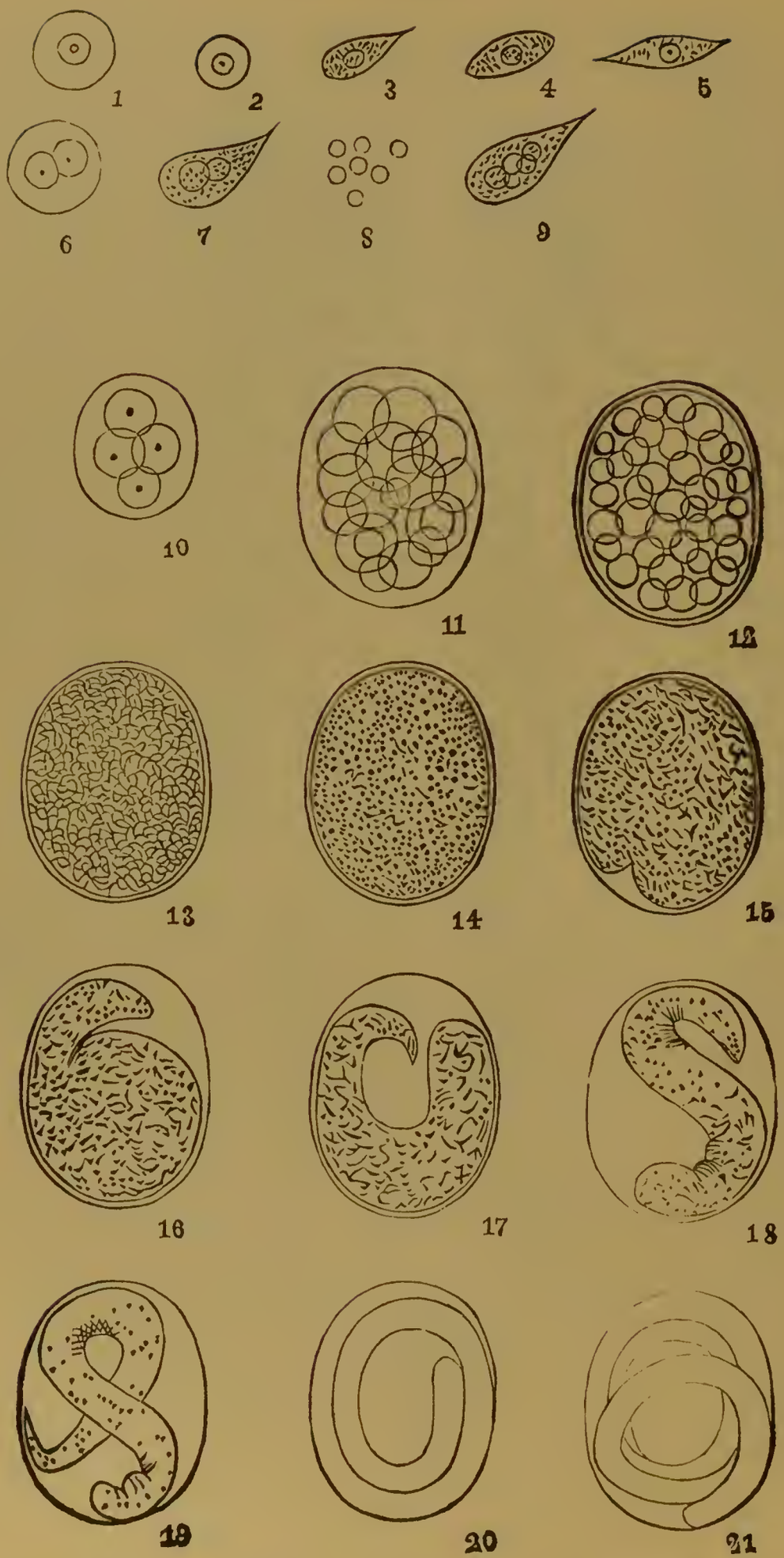

FIGURE IV.—DEVELOPMENT OF THE EMBRYO OF FILARIA IMMITIS.

tubes, division and subdivision of this nucleus proceeds, the cell increasing in size to $\frac{1}{750}$ by $\frac{1}{1000}$ of an inch, and acquiring the oval form which it maintains till (Fig. IV., 10, 11, 12) its maturity. By continued and minute subdivision of the nucleus, a mulberry mass is formed inside the envelope or shell. (13, 14.) An indentation is then observed at one point (15); this indentation deepens, and by degrees (16, 17, 18, 19, 20, 21) the semblance of the free embryo is shaped from the mass. When this process is perfected, the egg measures $\frac{1}{500}$ by $\frac{1}{800}$ of an inch. As its development advances, the embryo loses its granular appearance, and exhibits some amount of movement. Its movements gradually become more active, till towards the vaginal end of the uterus, the shell is burst, and shrivels up into an irregular granular membrane, and the embryo struggles out and swims about with all the vigour it afterwards displays when an independent organism in the blood. The liberated embryo measures from $\frac{1}{4000}$ to $\frac{1}{3000}$ in breadth by $\frac{1}{100}$ of an inch in length.

Figure V.—Caudal extremity of Filaria immitis (male), showing spicules and papillæ.

Reproductive Organs of the Male.—Close to the extremity of the tail (Fig. V.) and on its under surface, are two very delicate spicules enclosed in a sheath and apparently retractile. Their common sheath is close to the anus. One spicule is longer than the other, being attached higher up the body. Besides these, there is a double row of delicate pedunculated papillæ, six on each side of the anus; and farther back than these, three minute serrations, and at the very extremity of the tail, two very small tubercles. I presume that these spicules, and perhaps papillæ, communicate with the testicle by means of a vas deferens, but this communication I have not been able to trace, owing to the thickness and opacity of the fibro-muscular coat of the tail in the male worm. The testicle is easily made out; it is a long, simple tube occupying the

greater part of the body; it terminates opposite the union of œsophagus and intestine, by the last few lines of it doubling back and gradually tapering down to a point. (Fig. VI.)

Figure VI.—Anterior portion of Filaria immitis, male.

a. Alimentary canal.
t. Testicles.
s. Spermatozoa.

The Contents of the Spermatic Tube are represented by *s*.—They consist of a clear colourless fluid, in which minute shining elongated bodies are suspended. If the male is cut across near his caudal extremity, a drop of this fluid exudes. The spermatozoa measure about $\frac{1}{6000}$ of an inch in length.

How does Filaria immitis enter the Circulation?—We have seen the two extremes, so to speak, of the parasite's life; the minute structureless embryo, and the mature elaborately organized parent a foot in length. But I have met with no intermediate form; yet such there must be. Where to look for it I cannot suggest. I have searched in all the visceral and cervical veins, but without discovering a trace of such a form. Spleen, liver, kidneys, lungs, brain, all the viscera in fact, in every instance in which I have dissected them, have yielded no information. In his last report, Dr. Jamieson suggests that the large water filariæ he had under observation for some time might be the heart-worm of the dog, but this is extremely unlikely, if not impossible. Of the two hundred or more species of filariæ known to naturalists, many live an independent life and never become parasitic. Such were probably the specimens he watched. They are found in abundance in stagnant water, moist earth, and in a variety of different media. Many, however, are parasitic in birds, fishes, quadrupeds and molluscs, free in the intestine or imbedded in different tissues. Such, as a rule, are swallowed with the food, having previously undergone some advance in development in the body of another animal, in water, in moist earth, or on vegetables which the final host consumes. The degree of development effected in these temporary media consists essentially in the elaboration of an alimentary canal, and a boring

apparatus wherewith to penetrate the tissues and assist the animal in its progress to its future resting-place. Now, in the case of the Filaria immitis, after a residence more or less prolonged in some suitable medium, it is swallowed, or in some other way obtains access to the tissues of the dog; then, by means of the boring apparatus with which it has become provided, it penetrates, and working its way to some spot in or near a vein, it rests for a time, loses all trace of its boring apparatus, and grows from probably a microscopic animal to a length of many inches, and becomes provided with a complete set of reproductive organs. This accomplished, it finds its way along the vein to its final resting-place, the right side of the heart, where the important function, reproduction of its species, is performed. I cannot tell whether the parasite ever dies before its host, or if it dies what becomes of it, or what effect its death has on the dog. In what animal or other medium the first step in development is gone through, I can only guess at, and what the spot or tissue it lies perdu in till it finally enters the circulation, I cannot find out. Both these points it would be interesting and important to ascertain. That the latter is not the heart I feel certain, as imperfect animals of a much smaller size and at different stages of development would be found there. Such I have never seen. The smallest female I have measured has been over seven inches in length, and all I have examined have been sexually mature. It cannot be in the arterial system, as to get at the right side of the heart the capillaries must be traversed; and it cannot be on the distal side of the portal circulation, as it would be arrested in the liver. The receptaculum chyli, thoracic duct, or the venous system, exclusive of that passing into the liver, must be the channel by which the heart is reached, and the places where the immature animal should be searched for.

Diseases produced by Filaria immitis.—One must be careful not to attribute to this cause the death of every dog in whose heart worms are found. We have seen that nearly two-thirds of all dogs are thus affected, and that for the most part host and parasite are apparently in good health. But I think there are at least two forms of disease fairly attributable to Filaria immitis.

The position the worm occupies in the circulation is about the safest so large and fertile an animal could select. Were the left side of the heart its habitat, the consequences to the host would surely be much more formidable; for in such case, the animal, escaping from the ventricle (as is its habit), would pass into some small but important artery, and all the evils of embolism would follow. Or even if the unhatched eggs were to escape in any number, as I suppose they sometimes do, there would be the same danger from capillary plugging in the brain, spinal cord, and elsewhere. The capillaries of the lungs, however, act as a filter, and all products of generation too large to pass capillaries,—all the results of death if such a thing occurs, and the wandering parasite itself should he, as he so frequently does, leave the heart,—all these are arrested there; the free embryo, of a diameter smaller than a blood corpuscle, too small to do harm by its size, alone passes through. As a consequence of this filtration, the lungs may themselves be injured, and I put down tubercle, or tuberculoid disease, as an occasional result of this process. I have met with an appearance closely resembling miliary tuberculosis in the lungs of filaria-stricken dogs, and in many cases where no distinct tubercular appearance exists, the lungs feel, when squeezed between the fingers, as if they contained numerous minute particles of gravel.

The most frequent and important effects, however, are those that may be attributed purely to the mechanical interference with the valves of the heart, and the capacity of the pulmonary artery and branches. But it is astonishing how very considerable the bulk of the bunch or rope of worms extending through the tricuspid and pulmonary valves may become. In many instances it must be impossible for the valves to close properly, or for more than one-third of the full stream of blood to be transmitted by the pulmonary artery. Such an animal must of course be short-winded, and perhaps liable to attacks of syncope, especially on exertion or excitement, when the demands on the circulation are greatest. And it is after some occurrence, such as a fight, that death most frequently occurs. Possibly, then, the energetic working of the ventricle has forced one or two more worms suddenly into the pulmonary artery, or entangled them among the valves or chordæ tendineæ, and death may come suddenly or only after a day or two, during which breathlessness and other signs of failing circulation point to the probable cause of illness.

A Hint to Sportsmen.—It is unlikely that a dog with many worms in its heart can be of much use in the field; his wind will go in the first half-hour of work. I would suggest, therefore, for the protection of the sportsman who contemplates buying a dog in China, that he should have its blood examined microscopically by a competent person, and if embryos of Filaria immitis are found in any quantity, that he should not make the purchase.

Filaria Sanguinolenta.

I employ this name on the authority of Dr. Lewis, who adopts it from Schneider. The latter applied it to a filaria found imbedded in the walls of the stomach of dogs, the description of which Dr. Lewis says applies very closely to the animal found by him in the œsophagus, thoracic aorta and neighbouring parts of the pariah dogs of Calcutta. Dr. Lewis's description nearly corresponds with what I have observed in Amoy, and I have no doubt the parasites are identical. In the following notes I will confine my remarks strictly to what I have myself observed.

Its Prevalence.—Some idea of the extent of this may be formed from the fact, that of thirteen dogs slaughtered for the purpose of procuring specimens of this parasite, nine contained the living animal in different stages of development, or showed traces of its former presence. So that I think I may safely say that all dogs who have attained any considerable age are or have been its host, though the degrees of infection and accompanying lesions vary from that of the most trivial description to those of the utmost gravity.

Can its Presence be recognized during Life?—Dr. Lewis has always found it associated with free embryo filariæ in the blood, such as I have described as belonging to Filaria immitis, and he looks upon these embryos as the progeny of Filaria sanguinolenta. He is quite aware of the possibility of his being mistaken, but he thinks it unlikely, as in several instances in which Filaria sanguinolenta and embryo filariæ were present together, he pursued his search into all the principal blood-vessels for other forms of mature filariæ, such as might have given birth to the free embryos, but without finding any. Still, I think he is in error, and for the following reasons:—Embryo filariæ are found in the blood where there may be no aortic tumours; among the thirteen dogs just referred to, there were seven which, although contain-

ing Filariæ sanguinolentæ or exhibiting traces of their presence, yet had no free embryos of any sort in the blood, at least I did not find them; whereas, when Filaria immitis was present in the heart, free embryos were found in all but two cases. The two exceptions almost amount to a proof in themselves, for in one case *unimpregnated female* Filariæ immites were found without any male worm, and in the other a solitary male, while aortic sanguinolenta tumours were present, and breeding sanguinolenta females were found in the œsophagus. There are other reasons, which will appear by and by, why we should not consider the free embryos often associated with it as the progeny of Filaria sanguinolenta. I conclude, therefore, that beyond perhaps difficulty in swallowing, produced by the mechanical action of a Filaria tumour in the œsophagus, there is no reliable symptom by which Filaria sanguinolenta can be detected during life. If the fæces were carefully searched, and perhaps the urine also, eggs might be found, and constitute certain evidence.

The Habitat of Filaria sanguinolenta.—I have found specimens imbedded in characteristic tumours in the walls of the thoracic aorta, in the walls of the œsophagus, in the loose cellular tissue in front of the latter, and in the pleura; never elsewhere.

The Lesions it produces are very characteristic. On opening the thorax of an affected animal, and drawing the heart and left lung over towards the right side, the straight part of the thoracic aorta may be seen to be studded with small tumours, ranging in size from a small pea to a bean, and the anterior and lateral surfaces of the œsophagus bulged out by tumours perhaps as large as a walnut, and where several of these are in juxtaposition, a large lobulated tumour may conceal the œsophagus altogether. To the touch these tumours are hard, though at points there may be a feeling of deep fluctuation. If the aorta is excised and split open, its inner surface is found, at the points corresponding to the tumours on the outside, to be more or less deeply sacculated, the inner coat roughened, and the outer coats thickened. In the latter, worms at different stages of development (I have not found them very large in this situation) may be found, or perhaps the sacculation and external bulging may only be evidence that a worm had once been there, but has disappeared. When the worm has reached a certain stage in its development, a minute orifice can be seen on the inner surface of the tumour, communicating with the cavity containing the animal. Through this hole a purulent-looking fluid can be expressed; this, on microscopic examination, is found to be loaded with characteristic ova, and cells resembling those of ordinary pus. The tumours in the œsophagus occupy the muscular wall, and generally are much larger than those of the aorta. On the inner surface of the œsophagus a small hole is, as a rule, to be seen, perhaps several, communicating with the cavity of the tumour, and through this the purulent egg-laden fluid can be easily expressed; sometimes, and by no means rarely, part of the mature filaria protrudes through this hole and hangs loose in the channel. I have found connected with the œsophagus, mature tumours embedded as I have just described in the muscular walls, similar tumours cretified and enclosing fragments of a long dead filaria, small pedunculated tumours of filarian origin projecting into the channel, and long tunnels burrowing between the coats, in some part of which a parasite can be found. In addition to these, the more frequent situations, the animal may be found in large or small glandular-looking lumps in the areolar tissue of the posterior mediastinum, or encysted between the costal and pulmonary pleuræ. In all these situations I have found them, and all in the same dog. When

small, the parasite is found alone, closely invested by the peculiar tissue it seems to create around itself, lying as it were in a tunnel, but when mature, it is found loose in a larger tumour, in company with one or more (eighteen I found in one instance) all encapsuled in a common and perhaps cretified cyst, and floating in a purulent fluid.

Naked eye Appearances.—The mature female worm (Fig. II., page 17, 2. F.) measures from three to four inches in length, by about one-sixteenth of an inch in breadth; the male is shorter by an inch or more, and can be distinguished from the female by the simple incurvation at the tip of his tail. The colour in both sexes is a dark pinkish red. Rolled between the fingers, the body is found to be firm and hard, and when stretched yields, but does not rupture readily. The Filaria sanguinolenta exhibits similar movements to the Filaria immitis but they are more active.

Anatomy of the mature Filaria sanguinolenta.—The *coverings* are two, the integument, a delicate transversely-striped membrane, and the fibro-muscular, consisting, as in Filaria immitis, of strong coarse longitudinal fibres.

The Alimentary Canal extends the whole length of the body. The mouth is placed at the very extremity of the head, and is easily distinguished from that of F. immitis, by its six well marked lips. (Fig. VII., 4.) These lead to a narrow pharynx, which expands into a straight and capacious œsophagus, about one-third of an inch in length, which terminates in the intestine by a valvular arrangement similar to that in F. immitis. From this point the alimentary canal passes, in company with the uterine or spermatic tubes, in a tortuous course towards the anus, before reaching which it expands considerably, to contract again as it opens finally on the surface of the body, some little distance from the extremity of the tail. (5.) The walls of the alimentary canal are muscular, and are kept apart in places by a dark granular material, the food of the animal.

The Reproductive Organs of the Female resemble, in their arrangement, very closely those of F. immitis. The vagina opens near the junction of the œsophagus and intestine, and after a short convoluted course divides into the two uterine tubes. These expand, and running backwards and twisting round the alimentary canal at intervals, near the caudal extremity gradually taper down to the fine ovarian tubules. The latter do not expand again, as in F. immitis, but preserve the same calibre throughout their whole length, winding round the alimentary canal and each other in a very intricate pattern. (5.)

The Contents of the Female Reproductive Organs.—I have shown that the F. immitis is viviparous; the F. sanguinolenta, on the contrary, is oviparous. I have not studied the various stages in the development of the ovum, but, as observed in the purulent-looking fluid I have described as exuding from the mature filaria tumour, it is seen to be of a cylindrical form, the ends of the cylinder being rounded off. It measures about $\frac{1}{750}$ of an inch by $\frac{1}{1500}$. (1.) The embryo is visible in most eggs, doubled up in the interior, and if a little pressure is applied to the covering slide, the shell can be burst and the animalcule expressed. (2, 3.) As thus observed, the embryo measures about $\frac{1}{200}$ of an inch in length, and resembles in form that of F. immitis, though rather more truncated at the caudal extremity and exhibiting no movement.

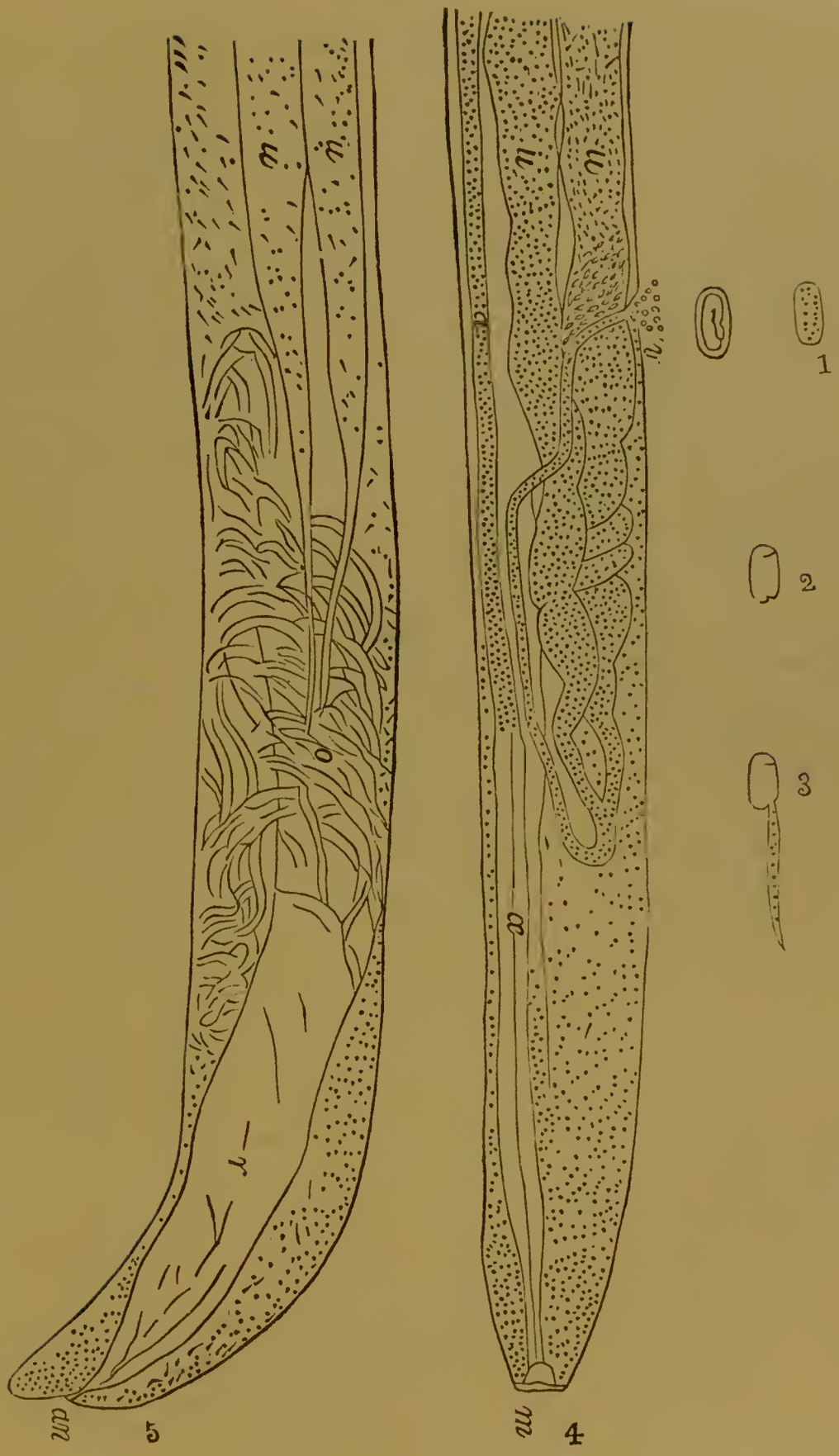

FIGURE VII.—FILARIA SANGUINOLENTA—Female.

1. Ova.
2. Shell; embryo escaped.
3. Embryo escaping.
4. Anterior end.
   m. Mouth with six lips.
   œ. Œsophagus.
   a. Intestine.
   v. Vagina; eggs escaping.
   u. Uterine tubes.
5. Caudal end.
   an. Anus.
   r. Rectum.
   o. Ovarian tubules.
   u. Uterine tubes.

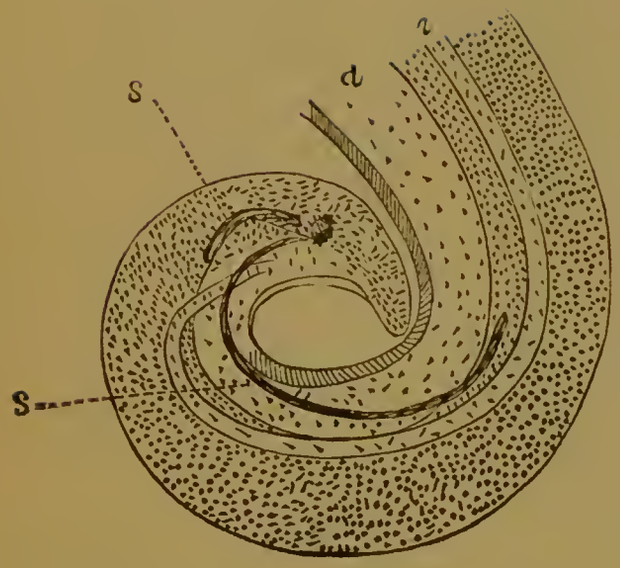

FIGURE VIII.—FILARIA SANGUINOLENTA—Male.

Caudal extremity.
a. Alimentary canal.
r. Vas deferens.
s.s. Spicules.

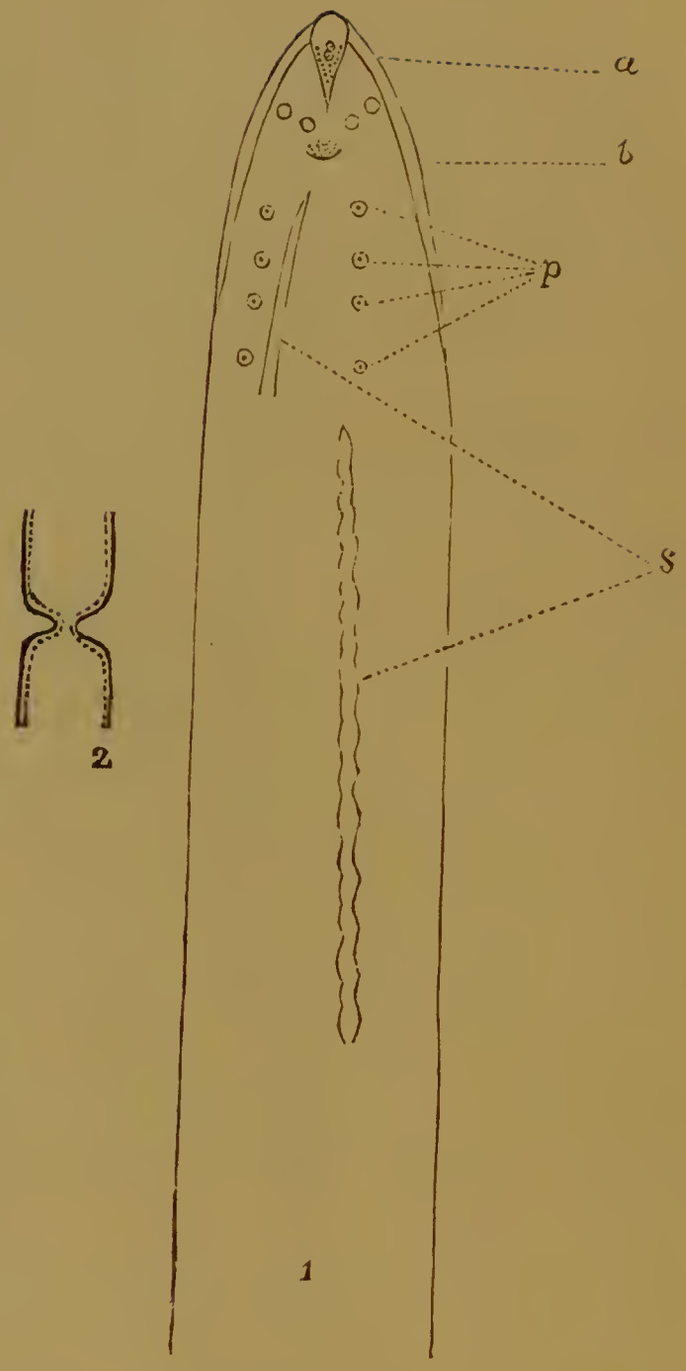

FIGURE IX.—FILARIA SANGUINOLENTA—Male.

1. Sketch plan of tail of male.
a. Leaf-shaped appearance at extremity.
b. Orifice of the sheath of spicules.
p. Papillæ.
s. Spicules.
2. Constriction between vas deferens and testicle.

Reproductive Organs of the Male.—If the under surface of the tail (Figs. VIII. and IX.) is examined, two rows of papillæ are seen on each side of the orifice of the sheath of the spicules and the anus, four in front of them, arranged in two lines parallel to the long axis of the body, and two behind placed obliquely. Viewed laterally, these papillæ are seen to have long pedicles. At the very extremity of the under surface of the tail is a clear space shaped like a rose-leaf, and in the centre of this are two more, but very minute, papillæ. The penis is represented by two spicules, one very long, attached farther up the body than the other, the shorter. In the specimens I have examined, the spicules were retracted, but the delicate outline of a sheath could be traced to a common opening in front of the anus, through which they are, I suppose, protruded. The tendons of a retractor muscle can be seen attached to the deep end of each spicule. I could not make out the connection of the vas deferens with the spicules and papillæ, but doubtless it exists. Traced upwards, a point is reached where the vas deferens contracts very abruptly (Fig. IX., 2) and the testicle begins; this extends to near the junction of the intestine and œsophagus, where the tube becomes doubled on itself, very much as in F. immitis; only the doubling is much longer, extending backwards for nearly half the length of the testicle, and when carelessly viewed giving rise to the idea that the testicle, like the uterus, is double.

The spermatic fluid I have not examined.

The mode by which Filaria sanguinolenta obtains access to the Tissues is made sufficiently clear by an examination of the tissues it attacks. From its being found in and near the œsophagus, we are justified in inferring that the embryo is swallowed, that it attaches itself to the walls of this tube, pierces them, and buries itself in the muscular coat, where a fibrous covering is formed around it; or, perhaps its journey is continued a very little farther, and it enters the walls of the thoracic aorta, or the posterior mediastinum. From all of these situations I have extracted specimens, varying in length from a few lines, in the immature animal, to upwards of three inches in the pregnant female. Small worms are most frequently found in aortic tumours, and on this account I incline to think either that they do not often attain maturity there, or that they leave it for the more favourable situation of the œsophagus. Immature worms are single and lie closely invested in their tunnels; the mature are always in company, sometimes in considerable numbers, and float loose in a fluid enclosed in a cyst. I infer from this diversity of arrangement at these two stages in the animal's history, that when the sexual organs have arrived at a certain point of development, the parasite resumes its perambulations, seeking out one of the opposite sex. In this way many are brought together, as where once a track is formed, others, on coming across it, are likely to follow it. I have seen an œsophagus dissected in various directions by long tunnels, at the end of which I found a parasite. When the sexes come together the female becomes impregnated, a small aperture is formed in the cyst leading to the channel of the œsophagus or aorta, and through this ova are poured into the alimentary canal or circulation; the female, more certainly to accomplish this, sometimes protruding her tail through the hole.

Is there any connection between Filaria immitis and Filaria sanguinolenta?—Considering that both are very frequently found in the same dog and intimately connected with the circulation, some might be tempted to suggest that they are of the same species, in different stages of development. But a glance at the physical characters of each is sufficient to establish

the impossibility of this. I give below, arranged in the form of a table for the sake of the contrast, the principal points of difference.

——	Filaria Immitis.	Filaria Sanguinolenta.
	Viviparous; active embryo $\frac{1}{100}$" in length.	Oviparous; motionless embryo $\frac{1}{250}$" in length.
Length	Never under six inches	Never over four inches.
Colour	Milky white	Reddish pink.
Mouth	Simple	Six-lipped.
Male	Corkscrew-like tail; spermatic tube tapers gradually to testicle.	Tail, a simple incurvation; vas deferens ends abruptly by a constriction.
Female	Uterus contracted abruptly to form ovarian tubes, which again expand to gradually taper to short terminal tubules.	Uterus gradually tapers down to ovarian tubules, which are long and do not again expand.
Habitat	Venous system	Arterial system and alimentary canal.

Diseases produced by Filaria sanguinolenta.—I believe there are three serious morbid conditions produced by this parasite.

1.—Stricture of the Œsophagus, more or less complete. This most frequently occurs when several large tumours are formed, especially when they are grouped together near the cardiac end of the tube, the most frequent locality. Regurgitation of food and slow starvation will be the consequence, unless the tumours diminish in size by the escape of their contents or death of the filariæ.

2.—Pleurisy. This is not uncommon in dogs here, and I think is often caused by the bursting into the pleura of a tumour which does not find vent for its contents by opening in the usual way into the œsophagus or aorta. I have found very distinct evidence of this occurrence in one instance. In it, worms were found crawling about amongst recent adhesions in the serous cavity.

3.—Paralysis of the Hind Legs. This is also common here, and is, I believe, caused by plugging of the capillaries of the spinal cord by ova escaping into the aorta. The brain is not affected, as the filaria tumours are seldom if ever situated on the cardiac side of the arteries proceeding to the head. Other affections are doubtless produced by the ova in the intestine, kidneys, and other viscera, but I have no knowledge of them or information to offer on this very interesting and important point.

Filaria Sanguinis Hominis.

The part played by Nematode Worms in Human Pathology.—The extent and importance of this is becoming year by year more recognized. In a former paper (*C. M. R.* No. 10, pp. 1–12) I pointed out the probable connection of a filaria worm with chyluria and elephantoid disease. The intestinal oxyuris and lumbricus are well known, as are also the strongylus gigas, the guinea-worm, and the trichina spiralis. The hæmaturia of the Cape, Egypt and the Brazils, is now acknowledged as depending on a similar parasitic cause, and I doubt not that, in time, many strange and at present unaccountable diseases of ex-European countries will be found to have a similar pathology. In my last report (*C. M. R.* No. 12, p. 37), I described a peculiar and

very prevalent form of stricture of the œsophagus I meet with in Amoy. Would not such a tumour in man, as I have shown is produced by filaria sanguinolenta in the dog, account for all the symptoms of œsophageal obstruction that I therein described? Could such lesions as this filaria produces in the aorta of the dog give rise to aneurism were they to occur in man? The great frequency of aortic aneurism among Europeans in China, and the prevalence of filaria aortic disease in dogs in the same country, is a significant coincidence. Another of our domestic animals, besides the dog, is well known to be affected by a penetrating filaria in China; the worm in the eye of the horse, which most medical men in China have, I suppose, been called on to extract, is another member of the genus. Seeing then that both the dog and the horse, man's most frequent companions, suffer from the presence of filariæ, is it improbable that man himself should be the victim of a similar intruder?

These are some of the conjectures which this study in what I might term comparative pathology has thrust on me, and I cannot but regret that native prejudice forbids their being put to the test of post-mortem dissection.

Confirmation of the conjecture that Elephantiasis Arabum is a Parasitic Disease.—I have lately found in the blood of a patient who came to me for the removal of an elephantiasis scroti, numerous specimens of embryo filariæ. I am thus enabled to state positively that elephantiasis Arabum is a parasitic disease, and to establish on solid and incontrovertible grounds, what in a former report I conjectured was the true pathology of this puzzling affection. Much, of course, remains to be done in working out the details of the exact operation of the cause, but the cue having been given, these will follow in time. A substantial basis, at any rate, is laid, to guide us in searching for means to prevent and cure a hideous and often fatal disease, afflicting a large proportion of the inhabitants of tropical and subtropical countries.

Since what precedes was written I have met with the filaria sanguinis hominis in the human blood no less than fifteen times.

With the practice I had acquired in the detection of hæmatozoa in the blood of the dog, I commenced some time ago the systematic examination of human blood. To help me in the work, which is excessively tedious and laborious, I familiarised two Chinese assistants with the appearance of the canino hæmatozoon, and showed them how to manipulate for the detection of similar organisms in man. No selection is made of cases, but the first patient or healthy person who presents and is willing to have his finger pricked, is examined; six slides of blood, at least, being carefully searched. In this way we have got over 190 cases, with the rather unexpected result of finding hæmatozoa in 15 instances, or in about 8 per cent. To prevent mistakes or imposition, when the parasite is found by my assistants, I take care to verify the observation for myself from a fresh specimen of blood, which I see drawn. I failed to find hæmatozoa in four instances in which they were reported, but I believe my assistants' observations were correct; they were confirmed by the persons who supplied the blood. Their horror at the snake-like animal they had given birth to was conclusive. As my re-examination was made some days after

the first detection of the parasites, it is likely that these had disappeared temporarily. This has happened in several instances I have myself closely watched.

FIGURE X.—FILARIA SANGUINIS HOMINIS.

The filaria sanguinis hominis resembles very closely in general appearance and movements the canine hæmatozoon described above. Accurate measurements are difficult to make on account of the restlessness of the animal when alive and the contraction which its body undergoes when fixed in desiccated blood. The short time when the blood is thickening, previous to thorough inspissation, is the most favourable for examining the animal; then, its movements are languid and admit of details being studied. From a number of observations, I conclude that it measures slightly less than $\frac{1}{2000}$ of an inch in breadth, by about $\frac{1}{90}$ of an inch in length, or thereabouts; on the whole its dimensions are rather under those of the canine variety. There are two or three points in which distinct and characteristic differences can be made out in the two species, when seen through a high power. The canine variety appears to be naked and structureless; the human, on the contrary, is provided with a very delicate noncontractile integument, within which the body of the animal is incessantly shortened and elongated. (See

Fig. X.) This, I believe, is the explanation of the appearance of a lash of extreme tenuity at the head and tail being sometimes visible, and sometimes not, and the occasional thickening of the extremity of the tail. The lash is the collapsed integument from which the head or tail has been withdrawn, and into which they are again projected. It seems to have no elasticity or spring, but follows like a limp string the movements of the body of the animal. Unlike the canine hæmatozoon, in many specimens of the human variety, though not in all, there is about the centre of the body an elongated yellow patch, the structure of which with the microscopic power at my command I cannot make out. I believe it appertains to an alimentary canal. On close examination with a high power, distinct movements as of a mouth can be made out at the extremity of the head. They resemble the breathing movements of a fish's mouth. The aperture, if aperture exists, is not simple, but, I think, is provided with several lips.

In a future report I hope to give details of all the cases I have examined for hæmatozoa; at present I will confine myself to short notes of the cases only in which they were found.

Case 1. *Hæmatozoa and Elephantiasis Scroti.*—Angkhi, male, æt. 58; from Changchiu, Lianho-sia; cake baker; in comfortable circumstances. Father died long ago, he does not know of what disease; mother died from fever and dysentery; two brothers are alive and well, one brother died from fever and dysentery. He states that when 28 years of age, in the spring of the year, he had an attack of what he calls ague, accompanied by inflammation of the scrotum; the fever lasted for but one day, but it was two months before the scrotum recovered its original size; before doing so it desquamated. Since that time he has had attacks of fever every year from four to eight times, each attack being accompanied by inflammation of the scrotum. Two years ago the scrotum did not as formerly recover after the fever, but remained swollen, and has grown steadily ever since. Formerly he was strong and stout, but for the last ten years he has lost flesh. Has never had chyluria.

His scrotum presents the usual appearance of elephantiasis. I suppose it to weigh about eight pounds. On its under surface there is a solitary vesicle about the size of a split pea, and near this a bunch of dilated lymphatics: pricking these places gives vent to a drachm or two of coagulable milky lymph.

Blood from his finger or scrotum contained numerous specimens of filaria sanguinis hominis; nearly every slide contained one or two. On the second day of his stay in hospital, filariæ could easily be found, though they had manifestly diminished in number. On the third day, though thirty slides were examined, not one specimen could be obtained, and during the five subsequent days, though frequent examinations were made, there was no reappearance of filariæ.

I was anxious to keep this man under observation for some time before operating on his scrotum, but the frequent examination of his blood seems to have alarmed his friends, and he was in consequence removed from the hospital unrelieved.

Case 2. *Hæmatozoa without concomitant disease.*—Sin-to, male, æt. 21; born in Tintai; came to Amoy about five years ago and became a pupil in the English Presbyterian Mission school. Does not remember to have suffered from any particular disease, except an attack of jaundice about four years ago, succeeding a smart fever (calls it ague) of one day's duration: his urine continued dark for about a month. He says he has been short-sighted ever since the jaundice. Never had abscess, boils, enlarged glands or anything resembling elephantiasis, lymph scrotum or chyluria, but has always been strong and healthy.

Being at the hospital one day, not as a patient, he saw a student examining the blood of a sick man; out of curiosity he submitted his own for examination. In six slides three filariæ were found in full activity. A week afterwards I found them in nearly every slide. A fortnight afterwards, I searched six full slides very carefully, but could find none.

Case 3. *Hæmatozoa and Lymph scrotum.*—Siah, male, æt. 45; a field labourer, lives in Lamoa, Choanchia. This man is intellectually very dull and his memory appears to be very imperfect, so that

a reliable account of his early history is difficult to obtain. One fact he dwells on with great obstinacy, perpetually recurring to it during his examination; viz., that for twelve years he has suffered from feelings of discomfort and pain in his bowels, grinding of his teeth at night, and frequent seminal discharges. When 16 years of age, and again at 28, he had attacks of fever. Three years ago he had frequent fits of what he calls ague, the fever never continuing for more than one day at a time, but recurring every week or two. But before this occurred he noticed that his scrotum was itchy and covered with vesicles, which, when broken, would exude fluid in great abundance for seven or eight days. The scrotum and inguinal glands gradually enlarged, but it was not until they had attained considerable size that he became liable to fever. Last year he had a course of quinine at the hospital; since then he has had only one attack of fever, four months ago, and of three days' duration, and his scrotum he says has diminished very much. During the attack of fever, he says that the scrotum was not affected, but that the glands were inflamed.

The scrotum is not very large, but it is a characteristic "lymph scrotum." The left inguinal glands are slightly swollen; the right inguinal and right upper femoral glands are very much enlarged, feel soft and doughy to the touch, and are evidently varicose.

During a residence of about a week in hospital, this man's blood was daily examined, and on no occasion were filariæ absent, varying in number from two to five in six slides.

Case 4. *Hæmatozoa without concomitant disease.*—Kim, a large-footed married woman, æt. 33, from Changchiu; came to hospital for ulcerated cornea and pannus of five years' duration. Her general health is good, though she has leucorrhœa, and at times aguish feelings. She is liable to swelling (œdema?) of the arms and legs. She has enlarged inguinal glands on the left side; these appeared about the time she came to hospital; they were painless, and have been considerably diminished by rubbing them. She says she is dyspeptic and at times breathless. Never had chyluria.

Filariæ are abundant in this woman's blood. Fourteen specimens were seen in six slides; they were found daily for a week.

Case 5. *Hæmatozoa, Fever, Enlarged Glands (and Chyluria?).*—Sia, male, æt. 22; native of Hooihoah; farm servant and coolie. His father has elephantiasis of the leg, and enlarged glands. When seven years of age he remembers to have had an attack of fever and inflammation of the glands. For the last four or five years has had frequent attacks of a fever like quotidian ague, each attack lasting for three or four days, and being accompanied by swelling of the inguinal glands. At present these glands are but slightly enlarged; the skin of the scrotum, however, is *perhaps* slightly hypertrophied. He says that when he has fever his feet become red and swollen. In the fifth month of last year he once passed chylous urine: this is his statement.

On examining his blood six slides were found to contain three hæmatozoa.

Case 6. *Hæmatozoa and Elephantiasis Scroti.*—Tso, male, æt. 50; native of Hooihoah; has been a chair coolie in Amoy for twelve years. For the last fifteen or twenty years has been subject every fortnight or three weeks to attacks of shivering, heat and sweating, each attack lasting only for two or three hours, and followed by lassitude and anorexia, incapacitating him for work for the day. These attacks are preceded and accompanied by aching about the right knee, and swelling of the inguinal glands, especially on the right side. No swelling at these times of the scrotum. Otherwise is quite well. Never had chyluria.

The right inguinal glands are enlarged, and the skin of the scrotum slightly but distinctly hypertrophied.

Filariæ were found in every second or third slide of blood. A week after the first examination, filariæ were again detected, but after another week in seven slides none could be found; that morning he had had one of his usual feverish attacks.

Case 7. *Hæmatozoa, Fever and Anasarca.*—Liengoo, male, æt. 34; native of and resident in Amoy; formerly a preacher and teacher, at present unemployed.

Until he was 29 years old never had any serious illness: that year he noticed a swelling of his legs. At 30 he had general dropsy for a month. At 31 had severe fever accompanied by delirium, and when the

fever left him he was dropsical and had a yellow complexion. After this attack he suffered from fever every month; he says he could tell the approach of the fever by observing that his body swelled, while his urine became scanty; fever was not preceded by rigor; when the fever subsided urine increased in quantity and the dropsy disappeared. These attacks always occurred at the end of the Chinese month, and would last from three days to a week at a time. During his thirty-second year, though his body was slightly dropsical, he had no fever. In the ninth month of his thirty-third year, he was weak and breathless; during the eleventh month his body again swelled, and he had attacks of fever more violent than before. Two months ago he had a very severe attack, accompanied by high delirium. I saw him at this time; he lay quite insensible in high fever, and his body was very much swollen; bedsores had formed over his sacrum. Under treatment by quinine, digitalis and nitre he recovered, the fever and dropsy subsiding and the sores healing. During the whole time he has been subject to these attacks, his appetite, even during the fever, has continued good. His friends say he is liable to maniacal attacks; his style of conversation and manner are certainly peculiar.

Heart and urine normal. Skin is yellow, flabby and coarse grained. Scrotum and inguinal glands partake of the general dropsy, but appear otherwise to be healthy. His blood contains filariæ in great abundance.

Case 8. *Hæmatozoa; no concomitant disease.*—Kim, female, æt. 23; Amoy; unmarried. Three years ago had a fever, supposed to be typhoid. Previous to this she was suspected of being phthisical, but since the fever, cough and all other symptoms of lung disease have disappeared.

Has never had chyluria or any affection of the lymphatic glands or integuments, and is apparently in good health.

This girl is the sister of the principal assistant in the Chinese hospital. Out of curiosity she got her brother to examine her blood, and in the first slide inspected three filariæ were found. The girl was shown the worms, and was so much alarmed by their appearance that she refused for a long time to allow any further examination. A few days ago I was allowed to examine her blood, and, although seven slides were carefully searched, no filariæ could be found. The specimens yielded by the previous examination I myself saw, so that there can be no doubt of the truth of her brother's statement. It may be worth while to mention that the day before the last inspection she suffered from slight feverishness.

Case 9. *Hæmatozoa and Lymph Scrotum.*—Toon, male, æt. 60; native of Lamoa, Toa Rhæ; a chair coolie; has lived in Amoy for eleven years.

Between 20 and 25 he became subject to attacks of fever and inflammation of the scrotum, coming on at irregular intervals of from a month to a year. These attacks have recurred more or less frequently ever since; sometimes, however, he has been free from them for a year or two. This year the fever is much less severe but it comes more frequently than formerly, the intervals between the attacks being only from four to six days. The fever resembles an ague very closely in its distinct division into cold, hot and sweating stages; but, unlike an ague, there is no regularity to be observed in the time of its accession, sometimes coming on at night, sometimes during the day, and not recurring at regular quotidian, tertian or quartan intervals. Each attack lasts about five hours, and is accompanied by slight swelling of the scrotum.

Never had abscess of scrotum, or chyluria. Two nights previous to examination he had one of the usual fever fits.

The scrotum is considerably enlarged, and varicose lymphatics on its surface yield a milky lymph on being pricked.

His blood contains abundance of hæmatozoa; one slide had as many as five specimens in full activity.

Case 10. *Hæmatozoa in a Leper.*—Nin, male, æt. 26; Lamcheng; shopkeeper; a leper for two years. I have no extended notes of this case, nor did I see hæmatozoa in his blood myself, though I searched many slides. My assistant, however, says that in the first slide he examined he found one, and his statement is confirmed by others.

Case 11. *Hæmatozoa with debility.*—Beng, male, æt. 22; Petsuia; a student in the Chinese Hospital.

As in the foregoing case, only one worm was found, which I did not see although many slides were subsequently examined. This lad suffers from debility, and though young has very bad teeth, bad complexion, has at times feverish attacks accompanied by feelings of languor. Has no swollen glands, or any appearance of elephantiasis, and has never passed chylous urine.

Case 12. *Hæmatozoa, Enlarged Inguinal Glands, Thickened Scrotum, Leprosy and Fistula in ano.*—Boo Kiong, male, æt. 38; Chinpo; farm servant; came to hospital to be operated on for fistula in ano.

Over his right malar bone is a patch of thickened skin, two inches in diameter, of a reddish colour and insensible to the touch. (Leprosy?) A near relation is leprous. No similar spots on any other part of the body. Was twice working in the Straits Settlements, five years at a time, and while there had ague; occasionally now has aguish feelings, and two years ago had an attack of fever, during which his scrotum became swollen and inflamed. At present the scrotum is slightly thickened, and on both sides the inguinal glands are enlarged.

My assistant found two filariæ in six slides. Next day I failed to find any, although a similar number of slides were examined.

Case 13. *Hæmatozoa; no concomitant disease.*—Sin, male, æt. 27; Oahai; shopkeeper; in good health.

When 16 years of age had an attack of ague during eleven days; has been much troubled with lumbrici, otherwise quite well. Inguinal glands readily enlarge when he has any irritation about his feet or legs, never otherwise. Is not subject to feverish attacks, never had chyluria; scrotum and glands normal.

An assistant found one hæmatozoon in four slides; he examined twelve more and I seven, but not another specimen could be found.

Case 14. *Hæmatozoa; no concomitant disease.*—An, male, æt. 28; from Oahai; a cooper.

Had ague when 16 or 17 years of age for four or five days; three years ago had an eruption on his legs and face; he describes the spots as being red, slightly itchy, and each about the size of a cash; it kept out for about a month. With these exceptions, has always had excellent health. Never had chyluria or enlargement of scrotum, legs or glands.

In six slides examined by an assistant, thirteen filariæ were counted. Next day the same assistant searched seventeen slides in order to show me a specimen, but without success. I pricked the lobule of the ear, and from blood thus obtained placed a full drop between two slides; in this I found one solitary specimen.

Case 15. *Hæmatozoa; Enlarged Glands and Abscess.*—Leng, male, æt. 30; Lamoa; a cobbler. Came to hospital on account of an abscess over the insertion of the right deltoid. I regret I cannot give this man's early history. His inguinal glands were enormously swollen and varicose, so much so that he was attempting to disperse the swelling on one side by the application of a native plaster. The scrotum was not affected.

There were no hæmatozoa in the first six slides examined, but the conviction I entertained on account of the characteristic appearance of the inguinal glands was justified two days afterwards, when on opening the abscess, many filariæ were found in the blood from the wound.

From these observations I think the following deductions are justifiable:—

1. That a large ratio of the population of this province, and probably of other parts of China, is infested with the Filaria sanguinis hominis. The exact ratio cannot yet be stated, but if my observations are a fair guide, one in thirteen is near it.

2. That the Filaria sanguinis hominis may be present in the blood, and yet the host be in good health, and exhibit no other morbid phenomena.

3. That in the same person it may be present at one time and absent at another.

4. That at one time or another it is very generally associated with elephantoid disease, and is almost certainly connected with the cause of such affections.

5. That it is sometimes associated with a diseased condition characterised by frequently recurring attacks of fever, accompanied by general anasarca unconnected with heart or kidney disease.

This last deduction I make from Case 7.—Liengoo. I have twice closely watched a similar train of phenomena, once in Formosa and once in Amoy. In both these instances, heart, lungs and urine were carefully and repeatedly examined, but nothing amiss with them could be detected. In one of the cases the anasarca, though general, was peculiarly distinct in the upper part of the body, suggesting pressure on the superior vena cava; but I could detect no aneurism or tumour of any sort to account for it. In both of these cases there was great prostration, weakness of the lower extremities, and, what I thought at the time an unjustifiably strong fear of death. Contrary to my prognosis, both died suddenly. I had come to consider that these were examples of beri-beri. After I became acquainted with Filaria sanguinis hominis, I speculated on the possibility of its having anything to do with them. When Case 7, Liengoo, presented himself, I made a shot at the diagnosis, and told my assistants he had worms in his blood. I was as much astonished as they were to find on examination that I was correct. This man is again ill with fever and anasarca.

I trust that others at the different ports will take up this enquiry as opportunity presents, and above all avail themselves of post-mortem examinations of Chinamen to search for the parents of the embryos found in the blood. Should I have an opportunity, I intend, before opening the abdomen, to follow up any dilated lymphatics I may find in the legs or scrotum, in the hope of encountering the cause of obstruction and probably the mature worm, in the glands, thoracic duct or their neighbourhood.

I would warn others against a hasty examination of the blood, and against concluding that, because no filariæ are found, none exist. For several years I have been in the habit of occasionally examining the discharge in lymph scrotum and the blood also, but until lately never encountered the Filaria sanguinis hominis. In fact, I kept a man for three or four years for the purpose of watching the progress of his lymph scrotum, and though I am convinced now that this man's blood contained filariæ, yet, on account of my examining probably only a small part of one slide and with a high power, I always missed them. At least six full slides should be examined, and every part of them carefully scrutinized. The power employed as a searcher should not be a high one, a quarter or half-inch is sufficient, but powers lower than these will do, provided they will distinctly define a blood corpuscle. If the light is too strong the very transparent body of the hæmatozoon is apt to be overlooked, at least it is not picked out so readily, and the eye of the observer becomes fatigued. If blood does not escape readily, or on slight pressure, from the prick in the finger or elsewhere, much force should not be used to express it, as the puncture is probably too small, and any filariæ the blood might contain will be hindered from escaping; a fresh puncture should be made. Another point the observer should attend to is, not to attempt to place too much blood under the covering glass; a small quantity should be scraped off the finger with the edge of the glass, and this placed with the charged part near the edge of the slide, and then slid along till the blood has almost reached the

circumference of the covering glass. This is an important point, as in nine instances out of ten the filariæ are found quite close to the edge of the patch of blood, and should this escape from below the covering glass, the chance of finding them is very small indeed. With attention to these details—which I again repeat are of the utmost importance to successful investigation—and with patience, I have no doubt that finds will be frequent, and I trust will be duly reported along with the failures.